

Contents

1 Preliminaries	1
1.1 General Introduction	1
1.2 The Reactive Paradigm: Its Basic Features	22
2 Natural and Formal Systems	45
2.1 The Concept of a Natural System	45
2.2 The Concept of a Formal System	54
2.3 Encodings Between Natural and Formal Systems	71
3 The Modeling Relation	85
3.1 The Modeling Relation within Mathematics	85
3.2 Specific Encodings Between Natural and Formal Systems	119
3.3 Encodings of Physical Systems	130
3.4 Encodings of Biological Systems: Preliminary Remarks	164
3.5 Specific Encodings of Biological Systems	168
3.6 Models, Metaphors and Abstractions	202
4 The Encodings of Time	213
4.1 Time and Dynamics: Introductory Remarks	213
4.2 Time in Newtonian Dynamics	215
4.3 Time in Thermodynamics and Statistical Analysis	223
4.4 Probabilistic Time	231
4.5 Time in General Dynamical Systems	237
4.6 Time and Sequence: Logical Aspects of Time	244
4.7 Similarity and Time	249
4.8 Time and Age	254
5 Open Systems and the Modeling Relation	261
5.1 General Introduction	261
5.2 Open, Closed and Compensated Systems	263
5.3 Compensation and Decompensation	269
5.4 The Main Theorem	272
5.5 Models as Closed Systems	277

5.6	The Concept of Error	283
5.7	Error and Complexity	297
5.8	Order and Disorder.....	300
5.9	The Stability of Modeling Relations	306
6	Anticipatory Systems	313
6.1	General Introduction	313
6.2	An Example: Forward Activation	320
6.3	General Characteristics of Temporal Spanning	325
6.4	An Application: Senescence.....	330
6.5	Adaptation, Natural Selection and Evolution	339
6.6	Learning	352
6.7	Selection in Systems and Subsystems.....	358
6.8	Perspectives for the Future	365
7	Appendix	371
7.1	Prefatory Remarks	371
7.2	Introduction	372
7.3	The Paradigm of Mechanics	376
7.4	Information	380
7.5	An Introduction to Complex Systems.....	386
8	Relational Science: Towards a Unified Theory of Nature	399
8.1	Introduction	399
8.2	R-Theory	401
8.3	Cause vs. Probability	406
8.4	Context: The Final and Formal Causes	409
8.5	Causal Closure	411
8.6	Modeling Relations	412
8.7	M-R Systems and Anticipation	414
8.8	Organization, Entropy, and Time	416
8.9	Conclusion	418
	Index	469

Anticipatory Systems
Philosophical, Mathematical, and Methodological
Foundations

Rosen, R.

2012, LX, 472 p., Hardcover

ISBN: 978-1-4614-1268-7